DRAFT
DEVELOPING A FOCUS FOR THE
ECOSYSTEM PROGRAM OF THE
CALFED BAY-DELTA PROGRAM
August 21, 1996

Summary

This paper argues that declining fish populations are the most serious Bay-Delta ecosystem problem. Potential causes of this problems are presented. Analyzing the causes of the fish problem would provide information useful to development of a comprehensive, effective Ecosystem Program. A method for conducting such an analysis is proposed.

Introduction

Much work has been done to give direction to the Ecosystem Program. Goals and objectives have been developed. Considerable thought has gone into developing biological indicators.

The purpose of this paper is to set forth a rationale for focusing the Ecosystem Program on the critical ecosystem problem, within the framework of goals, objectives, and biological indicators already developed.

The Basic Problem--Fish

We are all familiar with data showing a generally declining abundance of important species of fish over the period for which we have good data, generally the last third of a century.

The table on the next page was derived from these data. (These data, in the form of population trends over time, are available on request.) The table shows the years when abundance estimates were declining or were at low levels. The "X's" then, represent "bad" years for each species. The picture that emerges--**Declining populations for various species over the last third of a century.**

Consider what would have happened (or not happened) had these declines <u>not</u> occurred:

The State Water Resources Control Board would not have had such problems revising D-1485 and would not have been sued for failing to make those revisions.

DOCUMENTED DECLINES IN DELTA FISH ABUNDANCE

	SPECIES	PERIOD OF LARGE DECLINE IN POPULATION																																
		1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Anadromous	Fall Run Salmon	no data																											X	X	X	recov		
	Steelhead	no data															X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Winter Run Salmon	no data								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Spring Run Salmon, Sacramento River	no data																											X	X	X	recov		
	Striped Bass, Young-of-the-Year Index														X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Resident	Delta Smelt	no data												X	X	X	X			X	X	X	X	X	X	X	X	recovery						
	Longfin Smelt	no data								X	X	X	X	X	X	X	recovery									X	X	X	X	X	X	X	X	
	Splittail	no data						X	X	X	X	X	X	X	X	X	recovery								X	X	X	X	X	X	X	X	X	
	Starry Flounder	no data																					X	X	X	X	X	X	X	X	X	X	X	

The Delta smelt and Winter run salmon would not have been listed under the Endangered Species Acts.

EPA would not have proposed standards (X2 requirements) for the Delta.

There would have been no December 15, 1994 Accord.

There would be no CalFed Bay-Delta Program.

In other words, those declining fish populations are our foremost ecosystem problem. If the CalFed Bay-Delta Program does not directly address that problem, it will have failed to address the reason for its existence.

This is not to say that a goal of the CalFed Program should be to produce fish populations similar to those a third of a century ago. For one thing, that might be impossible.

However, these declining fish populations, because of their importance, provide a rational starting point for figuring out how to focus the Ecosystem Program.

Possible Causes of the Fishery Problem

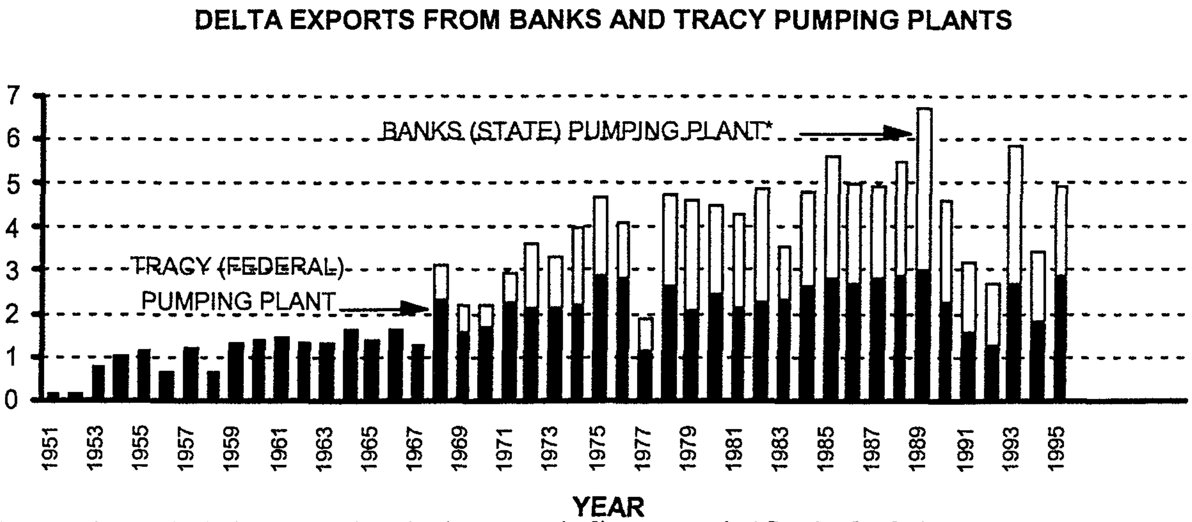
The obvious question is: What happened in the last third of a century that could have contributed to these fish population declines?

We ask this question not necessarily as a means of identifying the causes of the decline so that we can reverse these causes; some may not be reversible. Rather, we ask because the answer could provide information valuable to the development of a long-term ecosystem program.

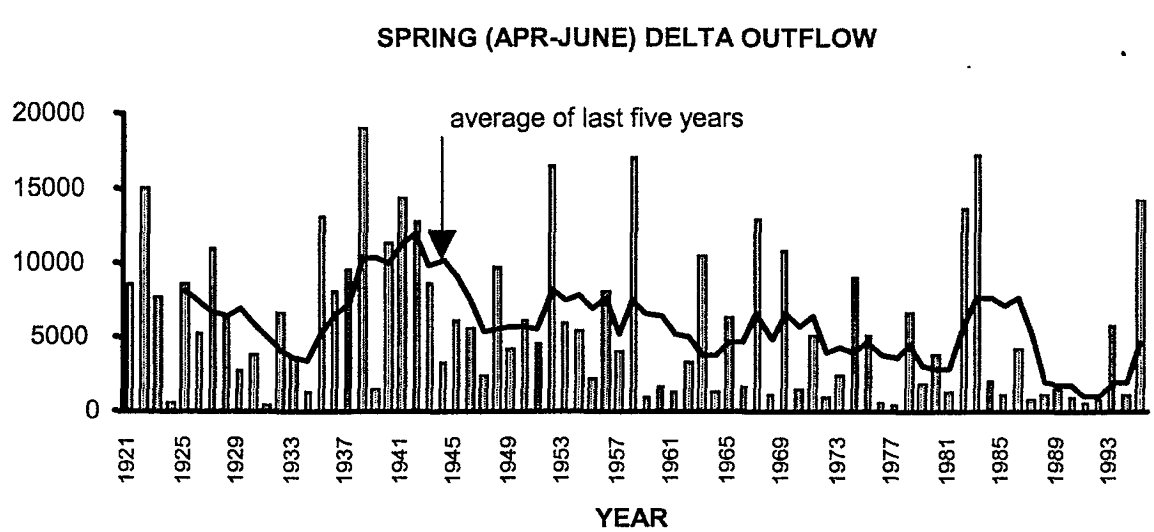
At least five primary factors appear to be worth considering with others as possibilities:

1. **Water project operations** have increased in intensity. Note that few water projects were actually built during this time, but those that had been built, especially the Central Valley Project and State Water project, were increasing their deliveries. We have good data on this

factor, and it has been extensively analyzed. Two curves, one showing Delta export and one showing spring Delta outflow are shown below.

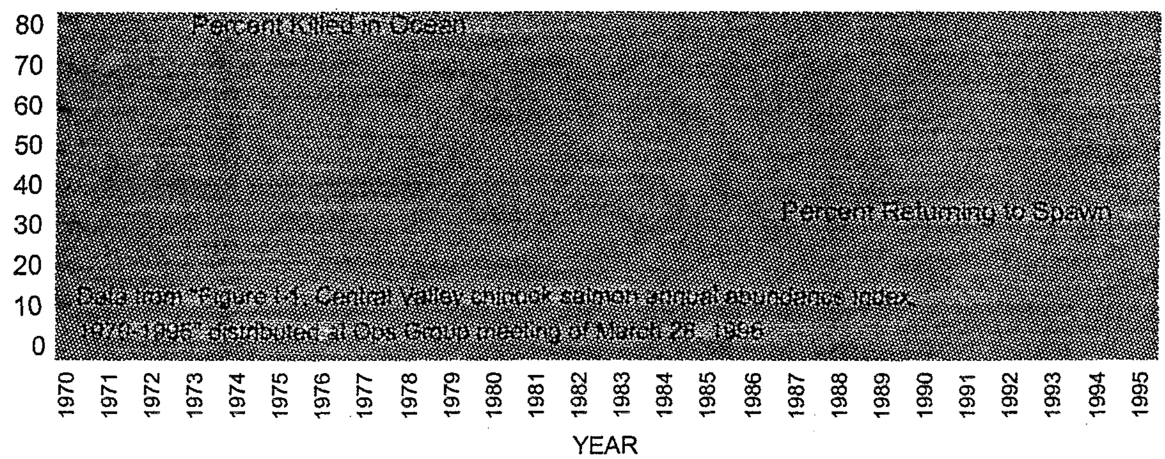


*State exports can include several hundred thousand af/yr pumped at Banks for federal use



2. **Fishing pressure** has increased. We know that there has been about a 30% increase in proportion of adult salmon being legally caught. We have some evidence of increased illegal fishing. A graph showing the increase in legal fishing is included below. An analysis of the potential importance of such an increase is available on request.

ADULT SALMON SPAWNERS AND OCEAN HARVEST



3. **Changes in toxics discharge**, especially pesticides, have occurred. We know there was a change from chlorinated hydrocarbons to organo-phosphates. (Chlorinated hydrocarbons persist in the environment. However, they also tend to adsorb to sediments, thereby leaving the water column. Organo-phosphates are not persistent, but until they degrade they tend to remain dissolved in the water column.) We suspect a general increase in pesticide use, but the pesticide application data have proven to be hard to get.

We have recent data that the Sacramento River (most of the water in the Delta is Sacramento River water) was lethal to the relatively hardy federal test fish, the fathead minnow, in five of seven samples during 1995. Other data reveal serious toxicity problems, probably attributed to pesticides, in streams and rivers throughout the Central Valley. These data are summarized below.

D-055138

Recent data on pesticides

Sacramento River toxic. 5 of 7 samples of Sacramento River water at Freeport throughout 1995 were lethal to fathead minnows, the standard, relatively hardy, federal test species. In 1993 elevated concentrations of diazinon were found in the Sacramento and San Joaquin Rivers after the two largest storms of the year. After the second storm, concentrations in the Sacramento River were toxic (i.e., lethal in standard bioassay using standard federal test species, Ceriodaphnia, water flea) as far downstream as Port Chicago.

Lower San Joaquin River toxic. Data collected in 1988-90 showed that a 43-mile stretch of the San Joaquin River between the mouths of the Merced and Stanislaus Rivers tested toxic about half the time. The cause appeared to be runoff from row and orchard crops.

All small water courses toxic. A 1992 study found diazinon at toxic concentrations in about half of all small water courses surveyed in the Central Valley during dry periods in January and February. After a large storm, all small water courses tested in the Central Valley were toxic, and toxic concentrations were found in the San Joaquin River for eight days.

Rain water toxic. In 1994 many samples of rain water from the Central Valley in January through March showed toxic concentrations of diazinon. Some samples contained concentrations 12 times higher than levels known to be toxic.

Several million pounds of pesticide applied. Each year in January and February about a million pounds of diazinon, chlorpyrifos, malathion, and methidathion are applied in the Central Valley on about a half million acres of orchards to control boring insects. In March and April about a million pounds of diazinon, chlorpyrifos, and carbofuran are applied to alfalfa in the Central Valley for weevil control.

4. We are beginning to get data indicating that **channel island, vegetated berm, and riparian habitat** have declined substantially in the Delta, probably resulting from increased boating and rip-rapping of Delta levees. A highly preliminary analysis of aerial photos of the Delta showed a 30 to 40% decrease in channel island area around four Delta islands in the last 25 years. There is a possibility that such near-shore habitat is important to fish and other species.

5. A large number of **exotic species** have been introduced into the system, and the frequency of introductions has increased in more recent times. Cohen's and Carlton's recent study for the Fish and Wildlife Service estimates that one new exotic species becomes established in the Bay-Delta system (not just the Delta) every 24 weeks and that the intensity of introductions, mostly from ballast water discharge, has increase in the recent past.

Three figures are included showing the spread of Potamocorbula amurensis (the Asian clam), the declining population of phytoplankton in the entrapment zone (the clams feed on phytoplankton and smaller zooplankton), and the declining population in neomysis, the tiny shrimp that young striped bass feed on. Recall that the outflow/export standards in D-1485 were set in part to protect neomysis, and it now appears that the clam is consuming the food for neomysis.

Other factors might also be considered, including:

Changing ocean conditions, such as El Nino, which affect the food supply for species such as salmon and may have effects on estuarine species assuming that the mixing of ocean food sources back into San Francisco Bay is important to key species.

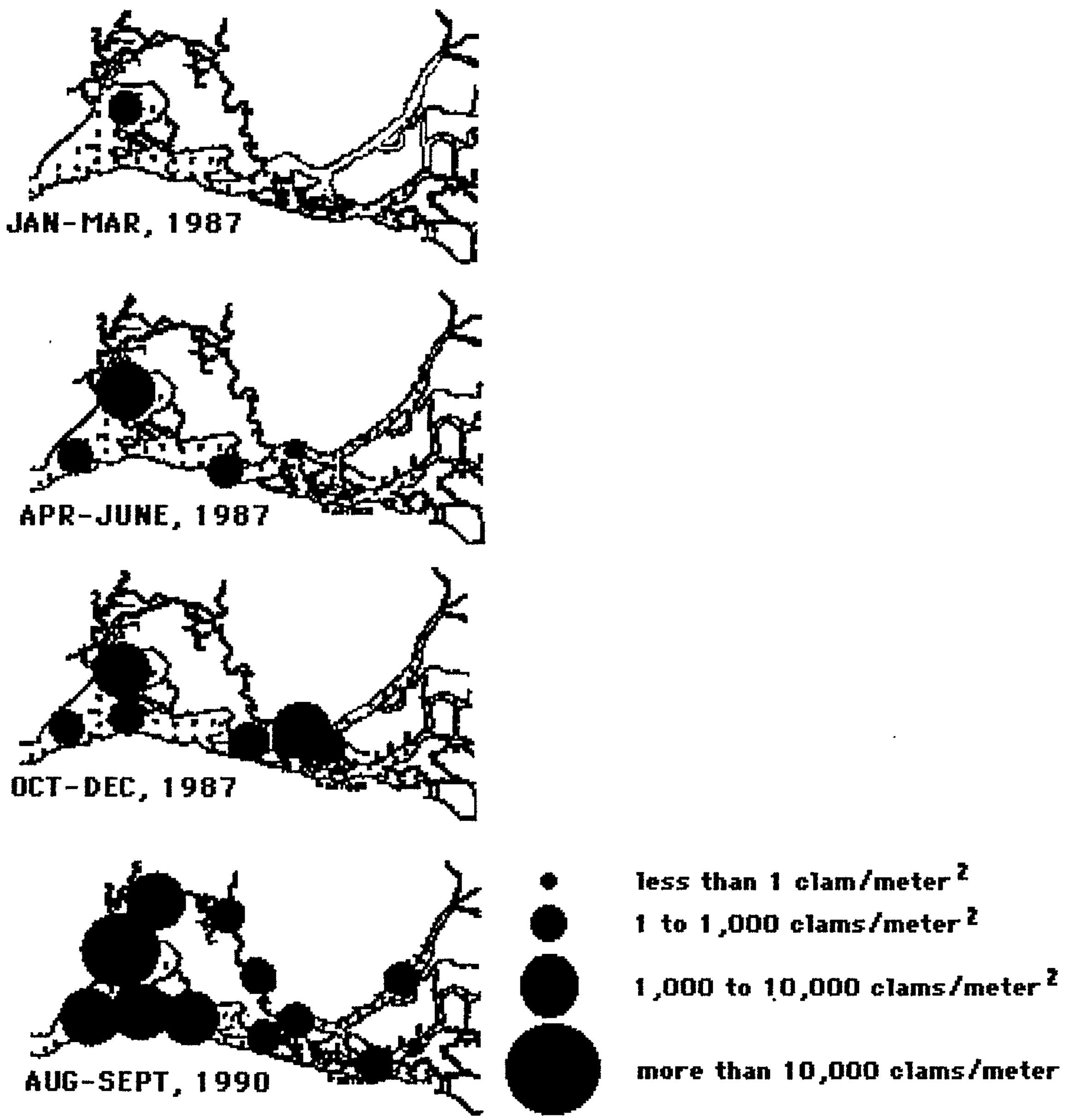
The second most serious **drought** in about 400 years, from 1987 to 1992, which had dramatic effects on habitat and food supply for a variety of Bay-Delta species.

The construction of and changes in operation of **hatcheries** which make high rates of harvest possible, thereby tending to deplete natural stocks, but which also may contribute to "natural" stocks because some fraction of hatchery fish stray into non-hatchery streams.

The **invasion and** subsequent attempts at **control of aquatic plant growth** in the Delta which not only alters Delta habitat but could also be causing toxic effects from chemicals used to control these growths.

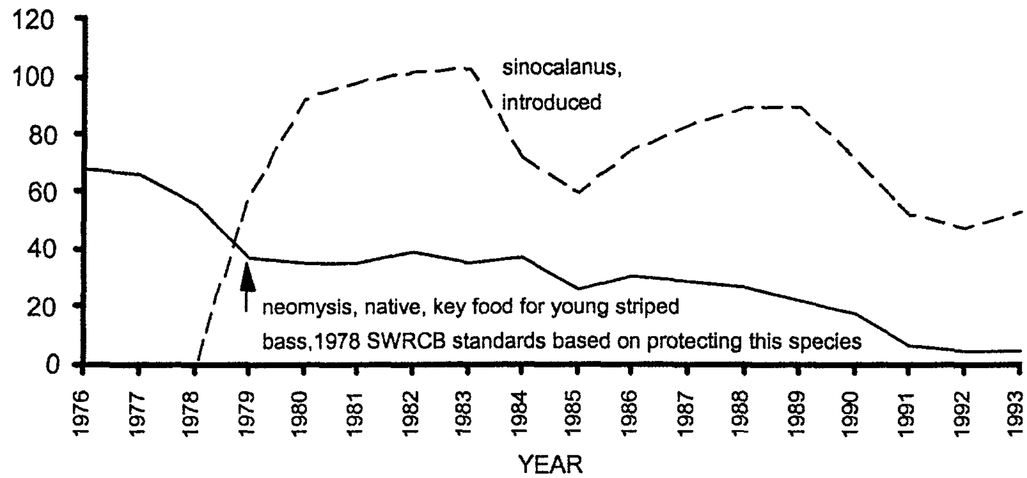
Dredging of gravel from stream channels which create large holes where predators of salmon and other species reside.

CONCENTRATION OF THE ASIAN CLAM, *POTAMOCORBULA AMURENSIS*, ON THE BOTTOM OF SUISUN BAY AND THE WESTERN DELTA

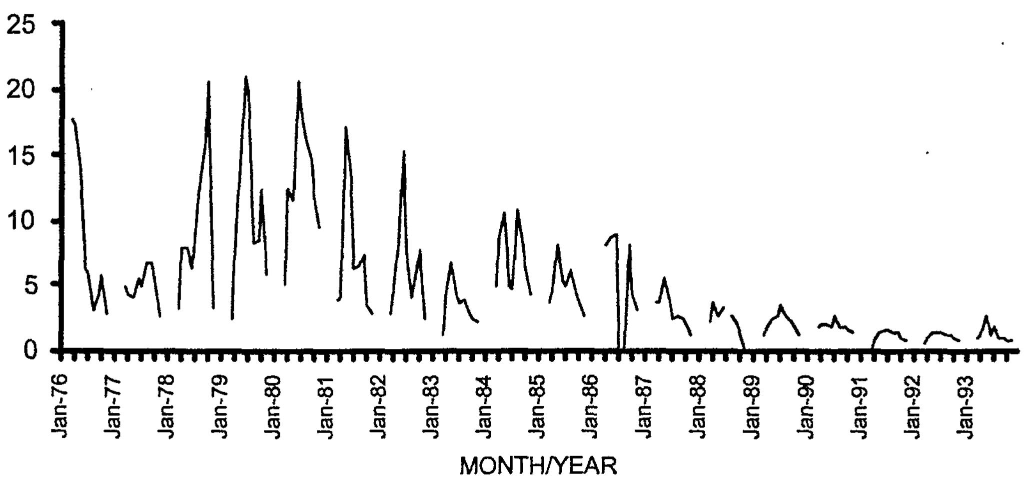


This clam was introduced into the Bay-Delta system from the ballast water of a ship, probably in late 1986. It spread rapidly, reaching concentrations of more than 20,000 per square meter. It has changed the ecosystem in the northern reach of the San Francisco Bay from pelagic (floating) to benthic (bottom). The clam feeds by filtering water through its system and removing small aquatic organisms. These organisms constitute the base of the aquatic food chain and consist of phytoplankton and small zooplankton.

NEOMYSIS AND SINOCALANUS IN DELTA
MARCH-JUNE, 5-YR AVG



CHLOROPHYLL (a measure of phytoplankton)
IN THE ENTRAPMENT ZONE



Increased **boating** in the Delta, especially the increase in use by large pleasure craft. We have generic data on the severe effects of boating, which include physical destruction of aquatic life by propellers, erosion and other disruption of shoreline aquatic habitat by boat wakes, large increases in turbidity, and pollution from fuel (exhaust from these boats is vented into the water).

Operation or changes in operation of **power plants** along the Contra Costa shore which entrain large numbers of a variety of species.

There may be other possibilities. There is no intent in this paper to limit these possibilities.

Analyzing the Effect of These Factors

This, of course, is the difficult part. How can these factors be analyzed? We all know how complex this system is, and we all know about data shortages, especially going back over a third of a century. However, if we pose the questions correctly, some powerful answers could be produced despite the complexities and data limitations.

The questions are:

For each factor listed above (or other factors that might reasonably be listed), is it likely that that factor played a significant role in the decline of fish populations over the last third of a century?

Is it likely that that factor inter-acted with one or more other factors to significantly affect fish populations?

What are the bases of these answers?

Note that these questions do not necessarily demand rock solid, conclusive answers. The questions reflect the fact that uncertainties will continue to exist.

Can these questions be answered? Probably, but the trick is figuring out how to proceed. Here is one possibility.

First, make sure the list of possible factors is complete. Talk to people who might have other ideas. Attempt to produce a list that would be widely accepted as reasonable. Revise as necessary.

Second, interview people who are knowledgeable about each of the factors. In these interviews we would be primarily looking for information that is supportable by data. We would not necessarily looking for commonly held beliefs, things generally accepted for a long time, possibilities, or theories. The idea in this second step is to produce a list of facts, backed up by data, on each of the potential factors. Disseminate this list of facts, and attempt to get wide-spread acceptance. Revise as necessary.

Third, Produce a short write-up (one to two pages) summarizing what these facts tell us about the importance of each factor. Identify major gaps in knowledge. Disseminate this list, and attempt to get wide-spread acceptance. Revise as necessary.

Fourth, Perform additional analyses. Use an "unfavorable assumption" technique. For example, for each factor, hypothesize that the factor has significantly affected fish populations. Then, perform whatever analyses are necessary to confirm that hypothesis. Draw on data from this estuary and from elsewhere as appropriate.

Whenever there is an important uncertainty in the analysis, make a reasonable assumption that would tend to produce the conclusion that the factor was not significant to fish populations. If we conclude from such an analysis that the hypothesis is true, that the factor did have a significant effect, then we will have some reasonable assurance that the factor was significant.

If, on the other hand, the analysis leads to the conclusion that the factor was not significant, we will need to check to see whether the factor could have been significant in combination with some other factor.

If we keep track of these assumptions, we can return to them and re-analyze with different assumptions to test the sensitivity of our conclusion to our assumptions.

Fifth, prepare a written description of these analyses and of the conclusions drawn from them. Disseminate this document and attempt to get widespread acceptance. Revise as necessary.

Sixth, prepare a final document of the implications of all the conclusions drawn from this process. Include implications for CalFed Bay-Delta alternatives as well as those for how the Delta should be managed. Disseminate this document and attempt to get widespread acceptance. Revise as necessary.